Test Tuesday 5/15

- Electrostatics
- Circuits

# Electric field equation:

$$E = \frac{k|q|}{r^2}$$

this gives the magnitude

direction comes from arrows of the electric field

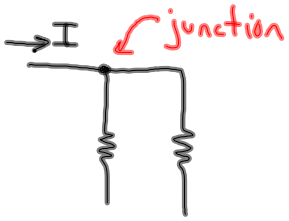
- if there are multiple charges, we must calculate an electric field from each charge

Resistors:

- The point is to control current
- Two main ways to connect pieces:

1. Series


2. Parallel (branching)



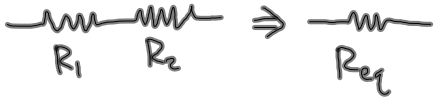

- There is a relationship between Voltage, current, and resistance:

$$V = I R$$

$V$ → voltage, $I$ → current, $R$ → resistance

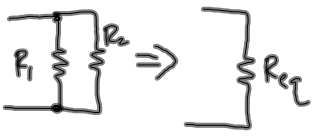
Ohm's Law

- Equivalent resistance:
  - Series:




$$R_{eq} = R_1 + R_2$$

  - Parallel:




$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$


Assume all wires have no resistance

$$V = IR$$

$$I = \frac{V}{R} = \frac{100\,V}{50\,\Omega} = 2\,A$$

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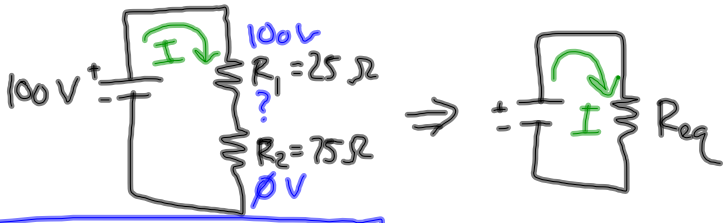



Pieces in series share current.

They have different voltage drops.

$$R_{eq} = R_1 + R_2$$
$$= 25\,\Omega + 75\,\Omega$$
$$= 100\,\Omega$$

$$I_{total} = \frac{V_{battery}}{R_{eq}} = \frac{100\,V}{100\,\Omega} = 1\,A$$

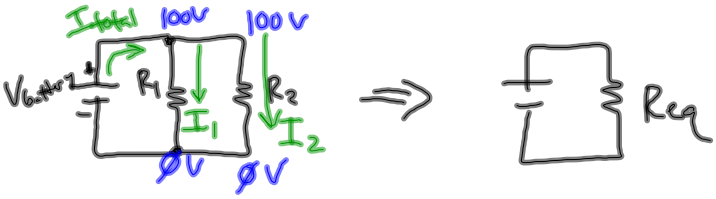
$$V_1 = I_{total} R_1 = (1\,A)(25\,\Omega) = 25\,V$$

$$V_2 = I_{total} R_2 = (1\,A)(75\,\Omega) = 75\,V$$

$$V_1 + V_2 = V_{battery}$$

$25\,V + 75\,V = 100\,V$ ✓

All voltage drops must add together to equal the voltage gain.




$V_{battery} = 100\,V$

$R_1 = 25\,\Omega$

$R_2 = 75\,\Omega$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$R_{eq} = \left[\frac{1}{25\,\Omega} + \frac{1}{75\,\Omega}\right]^{-1}$$

Calculator: $((1/25)+(1/75))^{-1}$

$$R_{eq} = 18.75\,\Omega$$

Pieces in parallel share voltage. They have different currents.

$$I_{total} = \frac{V_{battery}}{R_{eq}} = \frac{100V}{18.75\,\Omega} = 5.33A$$

$$I_1 = \frac{V_{battery}}{R_1} = \frac{100V}{25\,\Omega} = 4A$$

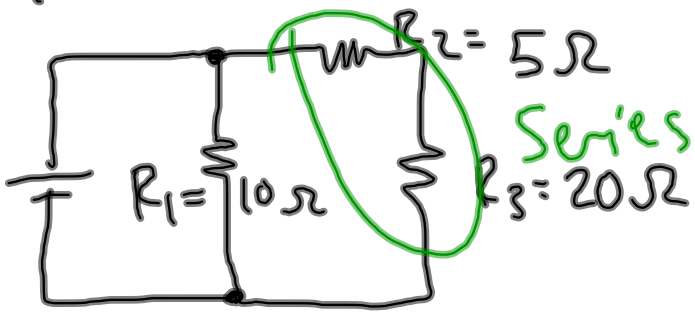
$$I_2 = \frac{V_{battery}}{R_2} = \frac{100\,V}{75\,\Omega} = 1.33\,A$$

$$I_1 + I_2 = I_{total}$$

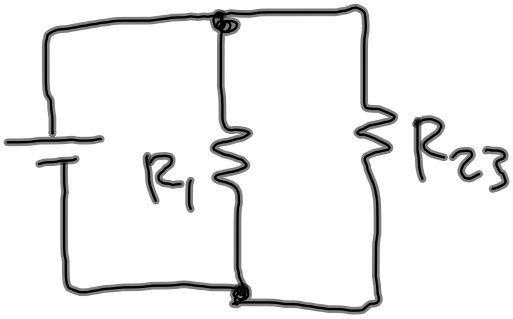
$4A + 1.33A = 5.33\,A$ ✓

Current in each branch must equal the current coming into the branches.

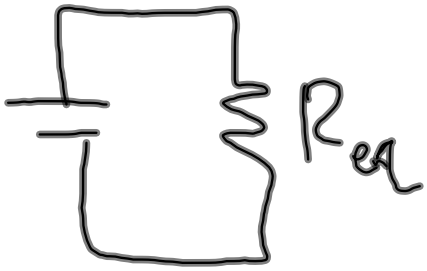
# Equivalent Resistance Practice:




Start outside and work in → farthest away from battery

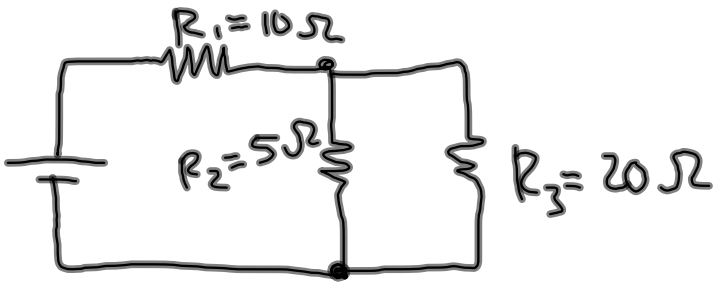


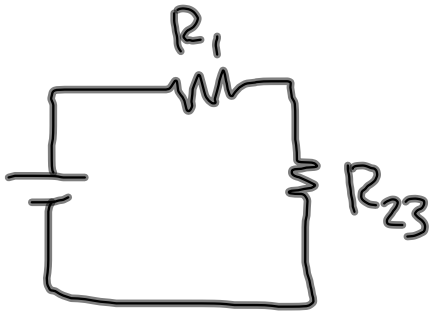

$$R_{23} = R_2 + R_3$$
$$= 5\Omega + 20\Omega$$
$$= 25\Omega$$




$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_{23}}$$

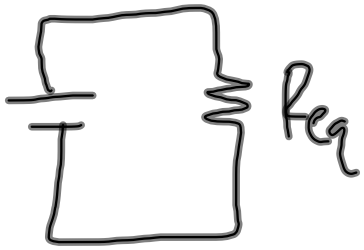
$$R_{eq} = 7.14\Omega$$




$$\frac{1}{R_{23}} = \frac{1}{R_2} + \frac{1}{R_3}$$

$$R_{23} = 4\,\Omega$$




$$R_{eq} = R_1 + R_{23}$$
$$= 10\,\Omega + 4\,\Omega$$
$$= 14\,\Omega$$

Electric Power:

$$P = IV$$

unit is still Watts

$$P = I^2R = \frac{V^2}{R}$$